DIFFERENTIATION OF CENTRAL AUDITORY PROCESSING DISORDER AND ATTENTION-DEFICIT HYPERACTIVITY DISORDER IN CHILDREN AND ADOLESCENTS

Laura J. Austin, B.A., M.A.

Dissertation Prepared for the Degree of

DOCTOR OF PHILOSOPHY

UNIVERSITY OF NORTH TEXAS

December 2000

APPROVED:

David Baker, Major Professor
Lisa Elliott, Committee Member
Paul Lambert, Committee Member
Timothy Lane, Committee Member
Earnest H. Harrell, Chair of the Department of Psychology
C. Neal Tate, Dean of the Robert B. Toulouse School of Graduate Studies

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CHAPTER I

INTRODUCTION

Many studies suggest evidence of overlapping symptoms between Attention Deficit/Hyperactivity Disorder (ADHD) and Central Auditory Processing Disorder (CAPD; Riccio &Hynd, 1996; Riccio, Hynd, Cohen, Hall, & Molt, 1994; Chermak, Somers, & Seikel, 1998). In fact, it is frequently argued that these two disorders are actually variants of the same neurodevelopmental process, and thus cannot be distinguished from one another (Riccio & Hynd, 1996). As such, it has been suggested that a diagnosis of ADHD vs. CAPD is largely dependent upon whether the assessment is performed by an audiologist or a psychologist (Keller, 1992). Although some may argue that these labels are arbitrary and unnecessary, such taxonomies provide efficient ways of communicating information with regard to treatment strategies, and thus can be useful in the development and implementation of interventions.

Unfortunately, few studies have sought to identify whether children diagnosed with ADHD can be differentiated from children with CAPD on the basis of psychometric assessment measures. The identification of such measures could aid in diagnosis and thus in the provision of optimal treatment based on an individual's specific deficits. Thus, the purpose of this study is to determine whether or not children diagnosed with ADHD or CAPD can be distinguished from one another on the basis of both objective and subjective assessment of attention and behavior.

Attention-Deficit/Hyperactivity Disorder

Attention-Deficit/Hyperactivity Disorder (ADHD) is a childhood disorder characterized by developmentally inappropriate levels of inattention, impulsivity, and/or

hyperactivity some of which must have caused impairment before the age of 7 and which are currently exhibited across at least two settings (Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, [DSM IV]; American Psychiatric Association, [APA], 1994). This disorder is divided into three subtypes: (1) Predominantly Inattentive Type (ADHD-I) which is characterized by significant symptoms of inattention, but not of hyperactivity/impulsivity, (2) Predominantly Hyperactive-Impulsive type (ADHD-HI) which is characterized by hyperactivity and/or impulsivity but not inattention, and (3) Combined Type (ADHD-C) which includes both inattention and hyperactivity/impulsivity.

Assessment

Assessment of ADHD typically includes a clinical interview, medical examination, and completion of behavior rating scales (Barkley, 1998). The purpose of the clinical interview is to review onset, length, and severity of symptoms which can assist the clinician in differential diagnosis, a task which is vital yet extremely complicated as many childhood disorders share clinical signs and symptoms. Completion of a thorough medical examination can rule-out any possible physical causes of reported symptoms (such as head injury, seizures, etc.,), identify comorbid physical conditions, and determine suitability for psychostimulant treatment of ADHD symptoms. Behavior rating scales are often completed by parents and/or teachers and provide information regarding current symptoms as compared to same-age peers. These measures are valuable diagnostic tools as they provide extensive, behaviorally-anchored information with little cost and minimal investment of time (Barkley, 1998). Checklists can be broad based, covering a range of pediatric psychopathology (e.g., CBCL; Achenbach, 1991), or may have a specific focus on symptoms of ADHD (e.g., Child Attention Profile; Barkley, 1990).

In addition to the clinical interview, medical examination, and use of behavior rating scales, clinicians may include objective assessment of attention and/or hyperactivity. Typical methods employed to this end include direct observation and neuropsychological measures of frontal lobe functioning (e.g., Wisconsin Card Sort Test, Stroop Word-Color Test, etc.). In addition, intelligence and/or achievement tests are often included in ADHD assessment batteries. However, while intelligence and achievement tests are useful in identification of cognitive factors which may contribute to inattention and academic underachievement (e.g., learning disabilities), these measures alone have not been found to adequately discriminate between normal and ADHD children, and thus should not be used as diagnostic tools in the absence of other data (Barkley, 1998). The most reliable objective measure for discriminating groups of ADHD children from controls is the paradigm known as the continuous performance test (CPT; Corkum & Siegel, 1993). The most common version of the CPT involves having the child observe a computer screen during the presentation of letters or numbers at a rapid pace. The child is told to respond by pressing a button when a certain stimulus appears. This test is the only psychological measure which directly measures inattention and impulsivity, the core symptoms of ADHD, without other confounds (e.g., conceptual ability, visual scanning, etc.). Overall, Barkley (1998) suggests that while psychological testing alone should not be used for diagnostic purposes, these methods can provide useful data to supplement information obtained from clinical interviews, medical examinations, and behavior ratings scales.

Etiology

The etiology of ADHD is believed to have strong neurodevelopmental origins, as irregularities in brain structure and neurochemicals have often been associated with the disorder. For example, researchers have found children with ADHD to have significantly

smaller right frontal lobes and decreased cerebral blood flow in both the prefrontal and right hemispheres as compared with non-ADHD children, important findings given the right hemisphere is believed to govern activities involving attention (Hynd et al., 1990; Lou et al., 1989). Frontal underactivity in individuals with ADHD has been attributed to deficiencies in neurotransmitter activity, particularly dopamine and norepinephrine (Hunt, Cohen, Anderson, & Minera, 1987; Zametkin & Rapoport, 1986).

Recently, a shift in the conceptualization of ADHD has occurred, suggesting this disorder reflects deficiencies in behavioral regulation rather than attention (Barkley, 1998; Barkley 1997). As such, impulsivity is viewed as the result of neurologically based deficits of rule-governed behavior due to either elevated arousal or elevated reinforcement thresholds (Zentall, 1985; Haenlein & Caul, 1987) which lead to problems initiating, inhibiting, or sustaining responses to stimuli and subsequent deficits in executive functioning and self-regulation (Barkley, 1997). Executive functions are control processes that coordinate cognition and knowledge and transform them into behaviors based on planning, problem-solving, and decision-making. Implementation of executive functions requires sustained and selective attention to allow for processing of both internal and external sensory stimuli, as well as memory to register, store, and retrieve knowledge and experience (Barkley, 1998). These processes involve many cortical and subcortical regions of the brain which can be affected by a host of biological and environmental stressors. This vulnerability may account for the frequency of executive function deficits in a variety of biological, psychological, and neuropsychological conditions including ADHD (Denckla, 1996).

Associated Features

Deficits in behavioral inhibition and executive functions likely impact many areas of development. Research on cognitive functioning in children with ADHD suggests

these children often evidence lowered IQ's (particularly verbal IQ's) as compared to controls (Barkley, 1998). While these differences may be a reflection of differing test-taking behaviors, it likely that deficits in attention and working memory (which rely on executive functions) also contribute to decreased performance on several subtests often included in IQ tests (e.g., Digit Span and Arithmetic subtests of the Wechsler Intelligence Scale for Children, Third Edition [WISC-III]). However, it is important to note children with ADHD compromise a heterogeneous group and thus reflect a range of intellectual functioning, from gifted to mildly mentally retarded (Barkley, 1998). With limitations in attentional and memory processes, it is not surprising many ADHD children have academic difficulties, and it has been estimated as many as one-third may evidence learning disabilities (Casey et al., 1996; Barkley, 1990). In addition to potential cognitive impairments, children with ADHD often evidence delayed development with regard to adaptive functioning (including motor-skills, self-help abilities, independence, and peer relationships) and speech and language development (Barkley, Fischer, Edelbrock, & Smallish, 1990). In particular, it has been suggested delays in the development of internalized speech may account for deficits in rule-governed behavior leading to impulsivity (Berk & Landau, 1993). Finally, children with ADHD have been found to evidence a vulnerability to emotional disturbance, and in particular evidence more symptoms of anxiety, depression and low self-esteem than controls (Biederman, Newcorn, & Sprich, 1991). The co-occurrence of ADHD and emotional difficulties can lead to problems with regard to accurate diagnosis and treatment.

Treatment

A variety of treatments are used for ADHD including individual, group, and/or play therapy, dietary management, allergy treatments, chiropractic therapy, and biofeedback (Pelham, Wheeler, & Chronis, 1998). However, in a review of empirical

literature, Richters et al. (1995) concluded that behavior modification, central nervous system stimulants, and a combination of the two are the only three short-term treatments which have been validated as effective treatments for ADHD. Using criteria established by the Task Force on Promotion and Dissemination of Psychological Procedures (Task Force; 1995), Pelham, Wheeler and Chronis (1998) concluded both behavioral parent training and behavioral classroom interventions can be classified as empirically supported treatments for ADHD. Parent and classroom interventions ADHD generally involve teaching parents and/or teachers behavioral techniques (e.g., time out, contingent attention, point systems) which are then used to design and implement contingency-management programs both at home and at school. While effective, short-term improvements from behavioral interventions are generally not as large as effects obtained in studies utilizing stimulant medication (Pelham, Wheeler, & Chronis, 1998). In fact, evidence from clinical studies support the contention that "stimulant medications have large, beneficial, acute effects on multiple, key domains of functioning in ADHD children" (Pelham, Wheeler, & Chronis, 1995, pg. 191). As such, according to Task Force guidelines, pharmacological treatments for ADHD are considered to be an already-established treatment against which all other treatments must be compared. Thus, research suggests children with ADHD should be treated with medication or with a combination of medication and behavior management.

Differential Diagnosis

ADHD is the most frequently diagnosed childhood psychiatric disorder, with prevalence rates estimated at between 6-9% in school-age children (Halperin et al., 1993). However, differential diagnosis of this disorder remains problematic, as difficulties with attention and impulse control are evident in many behavioral and emotional disturbances in children. While studies of attention, impulse control, and

activity level through the use of objective measures, observational techniques, and behavior rating scales consistently distinguish ADHD children from normal controls, these measures do not often provide evidence for significant differences between ADHD children and other psychiatric patient groups (Koriath et al., 1985; Shapiro & Garfinkel, 1986). Differential diagnosis is made even more difficult by the fact that rates of comorbidity are high in this population. In fact, research suggests that among clinical groups of children diagnosed with ADHD, as many as 50% may have a comorbid disruptive disorder, 25% may have an anxiety disorder, and 30% may have a comorbid mood disorder (Biederman, et al., 1991). Given these estimates as well as the lack of discriminant validity of core symptoms of ADHD (e.g., inattention, impulse control, and activity level), some researchers have questioned the validity of ADHD as a clinically distinct diagnostic entity (Halperin, et al., 1993). However, research has found that ADHD children are significantly more active that than both non-ADHD patients and normal controls, providing evidence for the divergent validity of ADHD as a disorder which can exist in a pure form (Halperin et al., 1992; Halperin, et al., 1993). Indeed, most researchers and clinicians would agree that ADHD is a valid diagnostic entity which can and does exist apart from other psychiatric disorders. Such opinions are not as common for another disorder that often co-occurs with ADHD; namely, Central Auditory Processing Disorder (CAPD).

Central Auditory Processing Disorder

CAPD is broadly defined by the American Speech-Language-Hearing Association (ASHA; 1992) as deficits in the processing of audible signals that cannot be attributed to impaired peripheral hearing sensitivity or intellectual impairment. These deficits involve limitations in the transmission, analysis, organization, transformation, elaboration, storage, retrieval, and/or use of information presented as audible signals. The disorder is

likely to be characterized by distractibility and inattentiveness, and may include problems with memory, reading, spelling, and written language (Riccio & Hynd, 1996). These problems are more prominent when listening to speech in the presence of background noise or in other poor acoustic environments. Individuals with CAPD have in-tact hearing but are unable to effectively process auditory information when it is relayed to the cerebral cortex; that is, these persons evidence difficulties with discrimination between similar tones or sounds (e.g., bat and cat), problems filtering sounds from background noise, and inability to correctly sequence words or phrases (Fowler, 1992).

Assessment

Assessments for CAPD generally include evaluations of: (1) sound localization; (2) sound discrimination - the ability to distinguish one phoneme from another; (3) ability to perceive the number and order of speech sounds within a spoken pattern; (4) segmentation, blending and rhyming; (5) minimal pairs- ability to discriminate words which vary by one phonemic cue (e.g., put-pet, shack-sack); (6) closure tasks- the ability to fill in filtered-out information; (7) figure-ground tasks- the ability to differentiate a foreground stimulus from a non-essential background stimulus; (8) verbal memory; and (9) competing words/dichotic listening- ability to selectively attend to words presented to one ear while filtering out words presented to the other ear (Moss & Sheiffele, 1994).

Etiology

Similar to ADHD, CAPD is believed to have a neurological basis. Research suggests CAPD is the result of neurodevelopmental delays, and both subcortical structures (including the brain stem, reticular activating system and corpus callosum) and the auditory cortex have been implicated as sources of dysfunction (Riccio & Hynd, 1996). Additionally, it has been found many children with CAPD suffered from chronic,

severe middle ear infections (otitis media) which likely caused damage to auditory fibers responsible for relaying auditory information to the brain (Fowler, 1992).

Associated Features

Children with CAPD have difficulty processing linguistic information, and thus, have been found to have concomitant delays in both expressive and receptive language (Cacace & McFarland, 1998). Additionally, CAPD has been linked to learning disabilities, particularly dyslexia and reading disability (Pinheiro, 1977). However, with regard to both language deficits in general and learning disabilities in particular, the question has been raised as to whether CAPD actually contributes to these deficits or rather is the reflection of a higher order processing deficit. That is, both CAPD and language/learning problems may be functions of more global processing deficits (Cacace & McFarland, 1998). Consequently, the validity of CAPD as a separate diagnostic category has been called into question. However, some researchers support the existence of CAPD as a diagnostic entity, as long as it is properly defined and assessed. From this perspective, CAPD is a modality specific deficit evidenced in the processing of acoustic information. As such, persons with CAPD should not evidence deficits when processing information via other modalities, and thus can be distinguished from individuals with language, attentional, and learning problems who do not evidence modality-specific deficits (McFarland & Cacace, 1995). However, controversy remains regarding attempts to differentiate CAPD from ADHD, given the overlapping nature of key symptoms of these disorders; namely, inattention, distractibility, and difficulty following directions.

Treatment

Treatment of CAPD is directed at two general goals: (1) improving the client's auditory and cognitive resources, and (2) enhancing auditory signals and improving the listening environment (Task Force on Central Auditory Processing Consensus

Development, 1996). Enhancement of the client's language resources is a vital component of CAPD therapy, as knowledge of phonology, grammar, and vocabulary can help the client fill in missing parts of speech signals caused by auditory system deficiencies. Speech and language therapy aimed at improving these language based skills can help the CAPD client begin to compensate for auditory deficits (Wren, 1983). Additionally, clients are taught other specific listening skills (e.g., consciously focusing on crucial aspects of spoken signals; monitoring levels of comprehension) to further improve language processing (Miller & Gildea, 1987).

In addition to working with clients to enhance language-processing abilities, CAPD interventions often make efforts to improve listening environments. For children with CAPD, this might involve enhancing acoustic signals and reduction of competing noise via preferential seating in the classroom. For more serious deficits, the use of an assistive listening device (such as an FM system in which the child is fitted with a "bug in the ear" attached to a microphone worn by the teacher) or amplification device can serve to both enhance acoustic signals and reduce background noise (Task Force on Central Auditory Processing Consensus Development, 1996). In general, parents and teachers of these children are encouraged to speak slowly, make eye contact to ensure attention to auditory signals, emphasize key words, and use graphic displays and gestures to improve auditory information processing (Keith, 1981).

Relationship Between ADHD and CAPD

The relationship between ADHD and CAPD is unclear, due in large part to the inclusion of auditory inattention in the conceptualization of CAPD. Children with ADHD often have deficiencies in auditory attention and thus, under a broad definition, could also be diagnosed with CAPD. However, narrow definitions of CAPD include

only deficits in processing auditory speech and language specifically, and thus restrict the overlap between ADHD and CAPD (Barkley, 1998).

Etiological Similarities

In a review of the relationship between ADHD and CAPD, Riccio and Hynd (1996) describe many pre- and postnatal etiological factors that have been found to correlate with both disorders. For example, both CAPD and ADHD have been associated with maternal substance use, anoxia or hypoxia, infectious diseases, and other complications with pregnancy or birth. Postnatally, both disorders have been correlated with otitis media with effusion. However, differences between the disorders have been discovered as well. For example, CAPD (but not ADHD) has been linked to prenatal hyperbilirubinemia, Rh incompatibility, and maternal diabetes.

Empirical Investigations

To date, no studies have been conducted to directly compare children diagnosed with ADHD to children with CAPD. However, several researchers have used experimental designs in an effort to further clarify the relationship between ADHD and CAPD. For example, Gascon, Johnson, and Burd (1986) assessed 19 children with Attention Deficit Disorder as specified in DSM-III (APA, 1980) on measures of central auditory processing. All nineteen children evidenced significant difficulties with central auditory processing tasks. Subsequently, all children were treated with psychostimulant medication and were re-tested. Fifteen of the nineteen children (79%) demonstrated significant improvements on central auditory processing measures with stimulant treatment. These authors concluded, "the clinical picture of 'central auditory processing disorder' is indistinguishable from that of attention deficit disorder" (p. 31). A follow-up study designed to correct some methodological weaknesses in this study was conducted by Cook et al. (1993). Criticisms of the original work included: (1) stimulant trails were

not blind, (2) no control group was included, and (3) tests assessing for CAPD were narrowly focused. The focus of this study was to correct these weaknesses in order to help determine (1) whether CAPD test scores would differ for children diagnosed with ADHD vs. controls, and (2) to study the effects of stimulant medication vs. placebo treatment on CAPD test measures. Fifteen boys who met criteria for attention deficit disorder and ten boys who did not have ADD were assessed on parent and teacher rating scales and were administered a battery of CAPD tests at intake and again after three and six weeks of treatment. Treatment consisted of either stimulant or placebo medication (selected in a double-blind fashion) for ADD participants. Controls were not given drugs or placebo. A diagnosis of CAPD was made if an individual scored below age-level on at least three of the five CAPD instruments administered. At baseline assessment, 12 of the ADD boys and none of the non-ADD boys met these criteria. The boys were re-tested at three and six weeks after treatment (either stimulant medication or placebo for the ADD group and no treatment for the non-ADD group). Significant improvements were noted for both behavior rating scales and CAPD measures for ADD boys treated with stimulant medication, but not for ADD boys administered a placebo or non-ADD boys. These results rule-out the possibility of the positive influence of practice or passage of time on performance on CAPD measures. The authors conclude that ADD and CAPD are highly related and are difficult to differentiate. Although they entertain the possibility that pure CAPD may exist, they advise ADD should always be ruled-out before such a diagnosis is made.

Other research has also found children with ADHD to demonstrate significant problems with auditory processing. Keith, Rudy, Donahue, and Katbamna (1989) found children with ADHD evidenced significantly lower scores on the Screening Test for Auditory Processing Disorders (SCAN) than controls. In a follow-up study, Keith and

Engineer (1991) found children with ADHD evidenced significantly improved performances on the Auditory Continuous Performance Test (ACPT) and the Filtered Word and Competing Word subtests of the SCAN when taking stimulant medication as compared to administrations of these measures without medication. Thus, it appears that children with ADHD often exhibit deficits in auditory processing and these deficits are improved by treatment with psychostimulant medication. However, it is important to note the ACPT has not been found to be useful in differentiating children with CAPD from children with comorbid ADHD and CAPD. Riccio, Cohen, Hynd and Keith (1996) investigated the validity of the ACPT in differentiating children with CAPD from children with both CAPD and ADHD. No significant differences between these groups were found and the total combined error score (omissions plus commission errors) was not effective in classifying participants with regard to the presence or absence of ADHD. As such, the researchers recommended the use of visual attention measures (such as a visual continuous performance task) for future investigations. It is significant to note, however, these researchers did find differences between CAPD and CAPD/ADHD children on other measures. Children with CAPD alone were found to have significantly lower ratings of inattention by teachers and parents as compared to children with comorbid CAPD/ADHD. Additionally, these children were rated by parents as less impulsive and hyperactive than were children with comorbid CAPD and ADHD.

While research appears to support the contention that ADHD children will evidence CAPD, it is not clear whether children with CAPD can all be diagnosed with ADHD. As such, some research suggests CAPD can indeed be distinguished from

ADHD. Riccio, Hynd, Cohen, Hall, and Molt (1994) explored the incidence of ADHD in 30 children who completed a comprehensive cognitive, language, and auditory processing evaluation and met diagnostic criteria for CAPD. The biological mother of these children was administered the Structured Interview for Diagnostic Assessment of Children (SIDAC) which includes questions based on symptoms found in the DSM-III (APA, 1980) and DSM-III-R (APA, 1987). Of the 30 participants, 50% met DSM-III-R diagnostic criteria for ADHD, with 33.3% meeting DSM-III criteria for Attention Deficit Disorder with Hyperactivity and 16.7% meeting DSM-III criteria for Attention Deficit Disorder without Hyperactivity. Additionally, 10% of the participants demonstrated significant impairments with attention in the absence of hyperactivity or impulsivity. While all children with ADHD may evidence deficits in auditory processing, it appears that not all children with auditory processing deficits meet criteria for ADHD. This study provides some evidence for the validity of CAPD as a separate diagnostic category when rigorous criteria are used to define CAPD.

In an effort to further clarify the distinction between ADHD and CAPD, Chermak, Somers, and Seikel (1998) surveyed 48 pediatricians and 33 audiologists to determine how professionals typically responsible for diagnosing these disorders rank behavioral symptoms associated with each. A list of 41 behaviors was provided to each professional who was asked to rate how frequently the behaviors were observed in children diagnosed with either ADHD or CAPD. Item analysis revealed two characteristics were frequently observed in both disorders: inattentive and distracted. However, nine behaviors were found to differentiate the disorders. For example,

difficulty hearing in background noise, difficulty following oral instructions, poor listening skills, and academic difficulties were rated as the top four behaviors associated with CAPD; however, these behaviors were not ranked one standard deviation above the grand mean of all items for the ADHD group. In contrast, pediatricians rated the following behaviors at least one standard deviation above the grand mean for characteristics of children with ADHD: hyperactive, fidgety or restless, hasty or impulsive, interrupts or intrudes. These behaviors were not rated one standard deviation above the grand mean for children with CAPD. The authors conclude that while children with ADHD and CAPD both present with symptoms of inattention and distractibility, these two disorders can be distinguished from one another. Pediatricians ratings suggest ADHD children generally demonstrate problems with heightened activity level and poor self-control while children with CAPD evidence difficulties attending to and processing auditory stimuli.

Overall, the relationship between ADHD and CAPD remains clouded. Research suggests not all children with CAPD can be diagnosed with ADHD (Riccio et al., 1994) and a survey of professionals demonstrated that audiologist ratings of behaviors associated with CAPD differs from pediatrician ratings of behaviors associated with ADHD (Chermak, Somers, and Seikel, 1998). However, to date no study has investigated if and how these two disorders can be differentiated from one another in a clinically referred sample. Additionally, although previous research has examined the difficulty associated with distinguishing ADHD from mood and anxiety disorders (Koriath et al., 1985; Shapiro & Garfinkel, 1986), to date, no study has been conducted in

which children with CAPD were compared with children exhibiting symptoms of anxiety and depression, despite the fact that inattention and distractibility are characteristic of each of these disorders.

Thus, the purpose of this study is to use objective, self-report, and parental report measures to clarify the relationship between ADHD and CAPD as they relate to each other and to symptoms of anxiety and depression. Distinct and meaningful patterns of performance on these measures would provide further support for the validity of ADHD and CAPD as clinically distinct syndromes.

CHAPTER II

METHOD

Purpose

The purpose of this study is to determine whether significant profiles of children with ADHD and CAPD can be distinguished from each using a sample of clinically-referred children and adolescents. It is hypothesized that, using objective, parental and self-report measures of attention, behavior and mood, children diagnosed with ADHD will differ significantly from children diagnosed with CAPD. Additionally, both of these groups will evidence patterns of performance that are unique when compared to children with other emotional or behavioral difficulties.

Participants

Participants were 84 children between the ages of 7 and 17 drawn from two outpatient clinics affiliated with a children's hospital in a southwestern state. All children were referred to the clinic for psychological testing due to behavioral and/or emotional problems. The participants were predominantly male (65%), and had a mean age of 10.14 years.

Measures

Visual attention and Concentration. The Conners' Continuous Performance Test (CPT; Conners, 1992) is a computerized measure of visual attention or vigilance. Individuals are presented with one-inch letters of the alphabet on a computer screen and

are asked to press a button for each letter they see, except the letter 'X.' The task is divided into six blocks, with three sub-blocks of 20 trials each. Inter-stimulus intervals (ISI's) are 1,2, or 4 seconds within a given sub-block, with a display time of 250 milliseconds. The entire task takes approximately 14 minutes to complete. Performance on the CPT is broken down into eleven categories: omissions (failure to press the button after presentation of a non-'X'), commissions (pressing the button after presentation of an 'X'), hit reaction time, standard error for hit reaction time, standard error variability, risk-taking (ß; a measure of response tendency with regard to risk-taking behaviors), attentiveness (*d'*; a measure of how well the individual discriminates between targets and non-targets), reaction time by block, reaction time by ISI, standard error by block, and standard error by ISI. Attention is measured by: (1) omission errors- the number of targets the individual did not respond to; (2) hit reaction time- the mean response time in milliseconds over all six time blocks; (3) standard error- the consistency of response times, expressed in terms of standard error for responses to targets; and (4) changes over time- inattention is indicated by unusual slowing of response speed and/or unusual increases in response variability as the test progresses. Impulsivity is measured by: (1) commission errors- the number of times the individual responded to a non-target ('X'), and (2) hit reaction time- particularly fast reaction times, especially when accompanied by a high number of commission errors, are indicative of impulsivity.

Logistic regression analyses were used to determine which of the eleven measures effectively distinguished general population individuals from persons with ADHD. Results were used to determine the relative importance of each measure and a weighted

sum was calculated to formulate an overall attention problem index which provided for the best false positive and false negative rates. Individuals scoring less than 8 on this index are classified as having no problems with attention; scores of 8 to 11 suggest possible problems which warrant further investigation; scores greater than 11 offer the strongest evidence of an attention problem (Conners, 1992). For the purpose of this study, the overall index was used for a measure of visual attention and concentration.

Reliability for the CPT as measured by split-half procedures has been measured at .72 for hits, .84 for commissions, and .71 for omissions. Test-retest reliabilities (time frame not reported) ranged from .65 to .74 (Halperin, Sharma, Greenblat & Schwartz, 1991). With regard to validity, various patient groups (including children with ADHD) have evidenced impaired performance as compared to controls (Klee, Garfinkel, & Beauchesne, 1986; O'Dougherty, Nuechterlein, & Drew, 1984). CPT performance of children with ADHD has consistently been shown to improve with stimulant medication treatment (Klorman et el., 1988; Klorman et al., 1991). Evidence for convergent validity of the CPT has been demonstrated with scores correlating significantly to behavioral ratings of inattention, impulsivity, and hyperactivity (Klee & Garfinkel, 1983) and to WISC-R subtests relating to attention (Seidel, W.T. & Joschko, M., 1991).

Auditory Attention and Concentration. The Goldman-Fristoe-Woodcock Test of Auditory Discrimination (TAD; Goldman, Fristoe, & Woodcock, 1970) is a 3 part measure which assesses auditory attention and concentration, as well as the ability to distinguish between speech sounds under differing conditions; that is, with and without significant background noise. This measure consists of 60 test plates each containing

four line drawings representing four common single-syllable words. On a test plate each word differs in either the initial or final consonants (e.g., pail, sail, nail, rail). Participants are asked to listen for the target word and then to point to the picture on the test plate corresponding to that word. Participants are initially presented with training plates containing words with little phonetic similarity to teach the vocabulary. Then, test plates are presented using an audio recording of target words under both Quiet (without background noise) and Noisy (with background noise) conditions. The subtest containing background noise consists of various cafeteria sounds and partially intelligible speech presented nine decibels lower than the signal. Errors are calculated and compared to the standard population of comparable age to derive percentile scores.

Test-retest reliability was found to be .87 and .81 for the Quiet and Noisy subtests, respectively. Internal consistency as measured by split-half reliability was .79 for the Quiet and .68 for the Noisy subtest. Convergent validity was demonstrated with .72 (Noisy subtest) and .68 (Quiet subtest) correlations between and TAD and clinician's judgements. Additionally, TAD performance by participants with speech and/or language problems was significantly worse than the performance of persons from the general population, providing evidence for construct validity (Goldman, Fristoe, & Woodcock, 1970).

Anxiety. The Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1985) is a 37 item self-report instrument designed to measure anxiety in children and adolescents ages 6-19. This measure is purported to be written at a third grade reading level and is thus read to children below this grade and to nonreaders.

Children respond to items with "yes" or "no." This measure consists of five scales: (1) Total Anxiety, (2) Physiological Anxiety, (3) Worry/Oversensitivity, (4) Social Concerns/Concentration, and (5) Lie Scale. The Total Anxiety Scale is expressed as a T-score (M=50, SD = 10) and the subscales expressed as scaled scores (M = 10, SD = 3). Norms are provided separately for males and females.

Reliability estimates (coefficient alphas) for the Total Anxiety score across 12 age levels range from .79 to .85. Stability coefficients for this scale ranged from .98 over a three-week interval to .68 over a 9-month interval. However, coefficient alphas for the individual subscales range from .15 to .80 across age, race, and sex, suggesting these subscales lack sufficient reliability to merit individual interpretation (Reynolds & Richmond, 1985). Reynolds and Richmond (1979) established the factor structure and construct validity of the scale. Additionally, several studies have investigated the convergent validity of the RCMAS using the State-Trait Anxiety Scale for Children (STAIC) as a criterion measure. For example, in a sample of 42 children, Reynolds (1980) found a .85 correlation between the RCMAS Total Anxiety scale and the Trait scale of the of the STAIC. In a study of 465 high IQ children, Reynolds (1985) found a .78 correlation between the RCMAS Total Anxiety scale and the Trait scale of the STAIC. Due to the lack of established reliability for individual subscales, only the Total Anxiety scale was used for this study.

Depression. The Children's Depression Inventory (CDI; Kovacs, 1992) is a 27-item self-report instrument designed to measure depression in children and adolescents between the ages of 7 and 17. This measure is based on the criteria of the Diagnostic and

Statistical Manual of Mental Disorders, Third Edition- Revised (DSM III-R; American Psychiatric Association, [APA], 1987). The reading level of this instrument is estimated at the first grade, and thus all nonreaders and children below this grade level are read the test aloud. Each item contains a three choice response format representing increasing levels of severity. Participants read all three sentences associated with each item and are asked to indicate "which item describes you best for the past two weeks." Items are scored from 0 (least "depressive" response) to 2 (most "depressive" response), and total scores range form 0 to 54. The measure is comprised of a Total score and five subscales: (1) Negative Mood, (2) Interpersonal Problems, (3) Ineffectiveness, (4) Anhedonia, (5) and Negative Self-Esteem. Scores are expressed as T-scores with a mean of 50 and a standard deviation of 10. Norms are provided separately for boys and girls and for youth age 7-12 and 13-17. The Total score was used in this study as a measure of overall depressive symptoms.

Kovacs (1992) reported the internal consistency (Cronbach's alpha) to be .86 for the Total scale and internal consistency estimates for individual subscales ranged from .59 to .68. Stability coefficients for this scale ranged from .87 over a one-week interval to .56 over a 6-month interval. However, this measure was constructed to measure state rather than trait depression and thus is not expected to remain stable over long periods of time. Convergent validity is supported by Bartell and Reynolds (1986), who found significant correlations between this measure and the Child Depression Scale (r=.70). Additionally, in studies of psychiatric inpatients, CDI scores for depressed children were significantly higher than scores of non-depressed children (Hodges, 1990; Knight,

Hensley, & Waters, 1988). Divergent validity is supported by Knight, Hensley, and Waters (1988) who found a correlation of -.79 between this measure and the Piers-Harris Self Concept Scale.

Parental Report of Behavior Problems. The Achenbach Child Behavior Checklist (CBCL; Achenbach, 1991) is a 113 item scale containing a list of behavioral problems which are rated by parents using a three point scale (0= not true, 1= somewhat or sometimes true, 2= very or often true). CBCL norms are reported for children and adolescents ages 4 to 18 and are provided separately for each gender. The CBCL consists of a Total score, two factor scores and eight subscale scores, all of which are reported as T-scores with a mean of 50 and a standard deviation of 10. The Internalizing factor is comprised of three subscales: Withdrawn, Somatic Complaints, and Anxious/Depressed. The Externalizing factor is comprised of the remaining five subscales: Social Problems, Thought Problems, Attention Problems, Delinquent Behavior, and Aggressive Behavior. To increase the power and robustness of statistical analyses conducted only the Internalizing and Externalizing factor scores were used in this study.

The CBCL has been shown to have sound psychometric properties, with internal consistency coefficients averaging .80 and one-week test-retest reliabilities above .80. Both internal consistencies and one-week test-retest reliabilities of the composite scores have been measured at .92 to .96 for the Externalizing and Total scores and .88 to .92 for the Internalizing score. Additionally, the CBCL has evidenced strong convergent validity with clinician clinical diagnosis as a criterion measure and has evidenced high concurrent correlations with related instruments such as the Conners' Parent Rating Scale and Quay

Problem Behavior Checklist. Total scores have been shown to be good predictors of psychopathology, with 95% of children and adolescents with T-scores above 75 coming from referred samples (Achenbach & Brown, 1991).

Demographic Information and Developmental Information. An extensive developmental history was provided by the parent(s) of each child. Information provided included family composition, presenting problem, medical and developmental history, sexual development, social development, school history, family history of psychological/psychiatric problems, and treatment history.

Procedure

Demographic information and CPT, TAD, CBCL, RCMAS, and CDI scores were be recorded from files of assessment clients at two outpatient psychology clinics affiliated with a regional children's medical center. Permission to collect this information was obtained from review boards of both the researcher's sponsoring university and the children's medical center. Participants were clients whose parents contacted an outpatient clinic by phone due to behavioral and/or emotional concerns. Basic demographic information was gathered over the phone and an intake appointment scheduled. Additionally, parents were sent a packet of information that included a developmental history form and a parent report form of the CBCL to be completed prior to the intake session. Initial clinical interviews were conducted with the client and his/her parent(s). Based on information obtained in this interview and the nature of client concerns, assessment appointments were scheduled and appropriate psychometric measures determined. Assessments were performed by either licensed psychologists or

Master's level practitioners under the direct supervision of a licensed psychologist. Participants completed assessments in a structured, one-on-one environment with minimal distractions. After completion of testing, feedback was provided to parents in the form of a formal assessment report. Children who performed poorly on the Test of Auditory Discrimination (below 32%ile on either subtest) were referred to a Licensed Audiologist or Licensed Speech Pathologist for a full Central Auditory Processing Evaluation. Results of this evaluation, if available, were incorporated into the assessment report and were included in this study.

CHAPTER III

RESULTS

Descriptive statistics including means, standard deviations and correlations among dependent variables are presented in Table 1. While some variables were significantly correlated with one another, no relationship exceeded .65. Thus, there was no evidence of multicolinearity among dependent variables.

To determine whether children with ADHD perform differently than children diagnosed with CAPD with regard to measures of attention/concentration, emotional and behavioral problems, participants were initially separated into one of four diagnostic categories based on diagnoses obtained from psychological testing profiles. Twenty- six participants were excluded from these analyses as they had not yet completed audiological testing and thus had no confirmed diagnostic status with regard to CAPD. The remaining 58 participants were divided into the following groups based on ADHD and CAPD diagnosis: 1) ADHD (n=20), 2) CAPD (n=7), 3) ADHD/CAPD (n=6), and 4) neither ADHD nor CAPD (to be referred to as the Affective Disorders group; n=25). It is significant to note many children in these groups evidenced significant mood symptoms concurrently with ADHD and/or CAPD symptoms. Specifically, 65% of the participants in the ADHD group were also diagnosed with significant symptoms of anxiety and/or depression. In the CAPD group, 29% had a primary diagnosis of an anxiety disorder, 42% were diagnosed with a depressive disorder, and 29% were

diagnosed with significant symptoms of both anxiety and depression. All of the participants diagnosed with both ADHD and CAPD were also diagnosed with significant symptoms of anxiety and/or depression. Finally, the Affective Disorders group was comprised of participants diagnosed with a primary anxiety disorder (58%), a primary depressive disorder (13%), or mixed symptoms of anxiety and depression (29%).

Once identified, these groups were compared across age and gender. While no significant differences existed across groups with regard to gender, the CAPD group (mean age = 12.8 years) was significantly older than either the ADHD ($\underline{M}$=9.64) or the Affective Disorders group ($\underline{M}$ =9.92; $\underline{F}$ (3, 54) = 3.148; $\underline{p}$ = .032). One-way Analyses of Variance were used to compare groups across dependent variables which included the CPT Total Index, TAD Quiet and Noisy subtests, CDI Total score, RCMAS Total Anxiety scale, and CBCL Internalizing and Externalizing scores. Before performing these analyses, the data were examined to ensure that basic assumptions of the ANOVA procedure were met. Outlier analysis did not suggest violation of the assumption of normality of the data. However, use of the Levene Statistic did reveal significant differences between within-group variability for both the TAD- Noisy ($\underline{F}$ (3, 54) = 6.82, $\underline{p}$ = .001) and CBCL- Internalizing measures ($\underline{F}$ (3, 54) = 2.88, $\underline{p}$ = .044). As such, the following results should be reviewed with caution. One-way Analysis of Variance procedures revealed significant differences between groups for auditory processing/complex attention (TAD-Noisy; $\underline{F}$ (3, 54) = 7.146, $\underline{p}$<.0001). Post hoc analyses utilizing the Tukey LSD method revealed children diagnosed with both ADHD/CAPD evidenced poorer performances on this measure of auditory

processing/complex attention than either children with ADHD alone (p = .005) or children from the Affective Disorders group (p <.000). Additionally, children with CAPD alone performed more poorly on this measure than did children with Affective Disorders (p = .009). Children with ADHD did not differ significantly from children with CAPD, or from children with Affective Disorders. Significant differences were also found between the groups on the measure of anxiety (RCMAS; F (3, 54) = 3.063, p = .036). Post hoc analyses revealed children with ADHD/CAPD and children with Affective Disorders reported significantly more symptoms of anxiety than children with ADHD alone (p = .036, and p = .010, respectively). No significant differences were found between groups on measures of depression (CDI; F (3, 54) = 1.89, p = .142), simple auditory attention/concentration (TAD-Quiet; F (3, 54) = 1.098, p = .358), visual attention/concentration (CPT; F (3, 54) = 1.22, p = .311), parental report of internalizing behaviors (CBCL-Internalzing; F (3, 54) = .586, p = .627) or parental report of externalizing behaviors (CBCL-Externalizing; F (3, 54) = .467, p= .707). While significant differences between children diagnosed with ADHD and CAPD were not found, some interesting trends were noted in the data, particularly with regard to visual attention/concentration and complex auditory attention/auditory processing. Specifically, children with ADHD scored in the mildly impaired range on the CPT overall index (M = 9.75) while children with CAPD performed within normal limits on this measure (M = 5.44). Interestingly, children with concomitant ADHD/CAPD scored in the significantly impaired range on the CPT Overall Index (M = 11.76). With regard to complex auditory attention/auditory processing (TAD-Noisy subtest expressed in percentiles), children with

ADHD scored within normal limits (M = 38.50), while children with CAPD scored in the impaired range (M = 24.57). Again, children with ADHD/CAPD were the most impaired on this subtest (M= 7.33). Means and standard deviations of dependent variables for each group are presented in Table 2. These groups were also compared on dichotomous items obtained from a developmental history form completed by parents during the psychological assessment (e.g., "Does your child evidence academic problems in school?" 1= yes, 2= no). Behavioral and academic variables found in previous research to discriminate between children diagnosed with ADHD and CAPD were examined using Chi Square analyses. Results of these analyses can be found in Table 3. Of these variables, only "Failure to complete school assignments" successfully differentiated between diagnostic categories (X^2 [3, N = 29] = 8.788, p = .032). Specifically, 75% of children in the CAPD group were reported by parents to fail to complete school assignments. However, only 10% of the ADHD group, 0% of the ADHD/CAPD group, and 16.7% of the Affective Disorders group were described as failing to complete schoolwork. The groups did not differ significantly on any of the following variables: history of ear infections, problems in school with attention, hyperactivity, reading or mathematics, or overall ratings of behavioral, emotional, or adjustment problems.

While true differences between these groups may not exist, it also could be that small sample sizes and thus reduced statistical power make detection of real differences impossible in this study. Therefore, in an effort to provide information about whether significant profiles of children with ADHD and CAPD can be distinguished from each other and from children with affective disorders, cluster analysis was performed using all

84 testing profiles. Again, the dependent measures were the CPT Total Index, TAD Quiet and Noisy subtests, CDI Total score, RCMAS Total Anxiety scale, and CBCL Internalizing and Externalizing scores. For these analyses, all scores were standardized to prevent over-weighting of any variable due to larger dispersion. Additionally, multivariate outlier analysis was performed to identify any observations that were not representative of the general population and thus could distort the structure of derived clusters. No outlier was identified and thus data from all 84 children were included in the analyses. Participants' standardized scores served as cluster variables and were entered into Ward's hierarchical algorithm, using Euclidian distance as the similarity measure. The resulting agglomeration coefficients were examined and a four-cluster solution was chosen, as it appeared to maximize within-group homogeneity and between-group heterogeneity while providing clinically meaningful profiles (see Table 4). Mean values and standard deviations of dependent measures for each cluster are reported in Table 5.

Cluster 1

The first cluster had no clinically significant score on any dependent variable. This cluster is described as the "Within Normal Limits" profile (WNL) and was comprised of 32 participants (38%).

Cluster 2

Profiles of participants in the second cluster were characterized by mild problems with visual attention and concentration (CPT Overall Index; M = 10.9), and significant deficits on measures of simple auditory attention/concentration (TAD-Q percentile; M = 21.14) and complex auditory attention/auditory processing (TAD-N percentile; M =

11.93). Additionally, participants in this cluster evidenced significant externalizing behavior problems (CBCL-Externalizing T score; M = 70.07). There were 14 participants (17%) in this cluster.

Cluster 3

Participants in cluster three evidenced significantly impaired visual attention/concentration (CPT Overall Index; M = 14.03), impaired simple auditory attention/concentration (TAD-Q percentile; M = 22.13) and mildly impaired complex auditory attention/auditory processing (TAD-N percentile; M = 30.48). Additionally, these participants reported mild levels of depressive symptoms (CDI T score; M = 61.48) and mild symptoms of anxiety (RCMAS percentile; M = 89.30). Cluster 3 was comprised of twenty-three participants (27%).

Cluster 4

Profiles of participants in cluster 4 were characterized by significantly impaired visual attention/concentration (CPT Overall Index; M = 12.96) and mild internalizing and externalizing behaviors (CBCL- Internalizing T score; M = 62.53; CBCL-Externalizing T score; M = 61.73). There were 15 participants in Cluster 4 (18%).

Within cluster membership, analyses were performed to examine differences between participants diagnosed with ADHD and those diagnosed with CAPD using the four diagnostic categories described previously (ADHD, CAPD, ADHD/CAPD, Affective Disorders). Table 6 presents results of analyses of possible predictor variables across the four clusters. Chi Square analyses revealed no differences between clusters with regard to either ADHD or CAPD diagnosis (X^2 [9, N = 58] = 7.4, p = .596). That is,

ADHD, CAPD, ADHD/CAPD and Affective Disorders diagnoses were evenly distributed across the clusters. Similarly, these clusters did not differ significantly with regard to gender ($\underline{X}^2$ [3, $\underline{N}$ = 84] = 3.865, $\underline{p}$ = 2.76) or to age ($\underline{F}$ [3, 80) = 1.78, $\underline{p}$ = .157). No cluster evidenced patterns of performance clinically consistent with a diagnosis of CAPD. However, several clusters (2, 3, and 4) demonstrated attentional deficits that would be expected of children diagnosed with ADHD or with concomitant ADHD/CAPD.

CHAPTER IV

DISCUSSION

Many researchers suggest Attention Deficit Hyperactivity Disorder (ADHD) and Central Auditory Processing Disorder (CAPD) are actually variants of the same neurodevelopmental process, and thus cannot be distinguished from one another (Riccio & Hynd, 1996). The purpose of this study was to determine whether or not children diagnosed with ADHD or CAPD can be distinguished from one another on the basis of both objective and subjective assessment of attention and behavior. Thus, children and adolescents diagnosed with ADHD, CAPD, and concomitant ADHD/CAPD were compared to participants with emotional problems on measures of attention/concentration, depression, anxiety, and parental reports of internalzing and externalizing behaviors.

First, performances of each group on dependent measures were examined and clinical profiles developed. Consistent with previous research, children diagnosed with ADHD alone were found to have mild to moderate deficits in visual attention and concentration (Horn, Wagner, & Ialongo 1989; O'Doughtery, Nuechterlein, & Drew, 1984; Barkley 1998). However, participants diagnosed with ADHD performed at the low end of normal limits on measures of auditory attention/concentration, auditory processing, and in the normal range on measures of depression, anxiety, and parental reports of internalizing and externalizing behaviors. Overall, these results are not

consistent with findings from previous studies. Rather, children with ADHD have been found to evidence poor auditory attention and processing (Gascon, Johnson, & Burd, 1986; Keith, Rudy, Donahue, and Katbamna, 1989) and significant externalizing behaviors (Barkley, 1998). Additionally, children diagnosed with ADHD generally evidence increased symptoms of anxiety and depression as compared to control groups (Barkley, 1998). It is significant to note, while overall parental reports of externalizing behaviors were within normal limits, reports of attentional problems on the CBCL for this group was in the clinically significant range.

Children diagnosed with CAPD, in contrast, were found to have clinically significant deficits in complex auditory attention/auditory processing and borderline levels of internalizing and externalizing behaviors. Visual attention/concentration, simple auditory attention/concentration, and self-reported anxiety and depression were all found to be within the normal range. Such modality-specific deficits in attention and concentration are consistent with studies that have attempted to differentiate CAPD from other attentional and language disorders (McFarland & Cacace, 1995). These problems with auditory inattention likely contributed to elevations in parental reports of externalizing behaviors. With regard to internalizing behaviors, no research exists to date examining the relationship between CAPD and these symptoms. However, in the current study all of the children diagnosed with CAPD also met criteria for a concomitant mood and/or anxiety disorder. These symptoms are reflected in the elevations on parental reports of internalizing behaviors.

Children diagnosed with both ADHD and CAPD evidenced severely impaired performances on a measure of complex auditory attention/auditory processing. Additionally, they had clinically significant deficits in visual attention/concentration and borderline levels of internalizing and externalizing behaviors. These children did not report significant symptoms of anxiety or depression, nor did they evidence clinically significant deficits in simple auditory attention/concentration. Again, these results have some support from previous research studies. For example, children with CAPD alone have been found to have significantly lower ratings of inattention by teachers and parents as compared to children with comorbid CAPD/ADHD (Riccio, Cohen, Hynd and Keith, 1996). Additionally, children in this group evidenced patterns of performance consistent with other studies of children diagnosed with ADHD. That is, they manifested deficits in overall attentional skills as well as internalizing and externalizing behavior problems (Barkley, 1998).

Finally, children in the Affective Disorders group evidenced borderline levels of internalizing behaviors. Scores on measures of visual attention/concentration, auditory attention/concentration, anxiety, depression, and externalizing behaviors were within normal limits.

Results of statistical analyses comparing these groups across dependent measures indicated children with ADHD/CAPD reported more symptoms of anxiety than children with ADHD alone. Analyses further revealed children with ADHD/CAPD evidenced significantly more impaired performance on a measure of complex auditory attention/auditory processing (TAD-Noisy) than children with ADHD alone or children

from the Affective Disorders group. However, it is significant to note within-group variability on this measure differed significantly between the four groups. As such, this statistically significant difference could be the product of chance and not reflective of true differences between groups. However, a closer look at the data revealed less within-group variability on the TAD- Noisy subtest in both groups of children diagnosed with CAPD, and more within-group variability on this subtest in the ADHD and Affective Disorders groups. Thus, it may be that children with CAPD, in general, perform poorly on this measure of complex auditory attention while children with ADHD alone or with Affective Disorders display a wider range of performance ranging from within normal limits to severely impaired. Clinical analysis of performances revealed that while mean scores of children with ADHD were not significantly different from children with CAPD on the TAD- Noisy subtest, clinically, children with ADHD scored within normal limits while children with CAPD evidenced impaired performances on this measure. These results are consistent with findings of previous research, as studies of attention, impulse control, and activity level through the use of objective measures, observational techniques, and behavior rating scales consistently distinguish ADHD children from normal controls, but do not often provide evidence for significant differences between ADHD children and other psychiatric patient groups (Koriath et al., 1985; Shapiro & Garfinkel, 1986).

With regard to demographic variables, only one item successfully differentiated children diagnosed with ADHD from those with CAPD. Specifically, 75% of the CAPD

group were described by a parent as failing to complete school assignments while only 10% of the parents of children with ADHD reported this problem.

In general, small sample sizes made statistical analysis of ADHD and CAPD profiles difficult. To further investigate the relationship between ADHD and CAPD, a larger sample of children (many of whom had not yet been tested for CAPD) was utilized in an exploratory cluster analysis procedure to determine if patterns of performance consistent with ADHD and/or CAPD could be identified. Analyses of patterns of performance across dependent variables lead to the identification of four distinct clusters. Thirty-eight percent of participants were included in Cluster 1. These participants had no clinically significant score on any dependent variable. Cluster 2 included 17% of participants in the study. Profiles of these children were characterized by mild problems with visual attention and concentration, significant deficits on measures of simple auditory attention/concentration and complex auditory attention/auditory processing, and significant externalizing behavior problems. Participants in Cluster 3 evidenced significantly impaired visual attention/concentration, impaired simple auditory attention/concentration, mildly impaired complex auditory attention/auditory processing, mild levels of depressive symptoms, and mild symptoms of anxiety. Cluster 3 was comprised of 27% of participants in the study. Finally, profiles of participants in Cluster 4 (18% of sample) were characterized by significantly impaired visual attention/concentration and mild internalizing and externalizing behaviors. Analyses of these clusters revealed no distinct pattern of performance for children diagnosed with either ADHD or CAPD. Rather, participants with these diagnoses were evenly

distributed throughout the clusters. Additionally, no cluster clearly represented the expected clinical profile for a diagnosis of CAPD- namely, significant auditory attentional/processing problems in the absence of other attentional difficulties.

Overall, statistical analyses did not reveal significant differences between performances of children diagnosed with ADHD and those diagnosed with CAPD. However, clinical comparisons across groups of children diagnosed with ADHD, CAPD, comorbid ADHD/CAPD and Affective Disorders revealed condition-specific clinical profiles, thus providing some support for CAPD as a distinct clinical entity.

The present investigation has several methodological limitations. Sample sizes across the study were small, particularly with regard to groups of children diagnosed with CAPD and comorbid ADHD/CAPD. As such, statistical power is limited and significant differences that may indeed exist between these groups may not have been detected. Generalizability of these results is limited as well, as participants came from a small geographical region and were almost exclusively Caucasian. It is possible that children from different geographical regions and/or diverse ethnic backgrounds would evidence different patterns of performance across the measures administered. Another variable that makes interpretation of current results problematic is the lack of homogeneity within groups with regard to diagnostic status. Most of the participants in this study were diagnosed with at least two behavioral and/or emotional disorders. Although comorbidity of childhood emotional and behavioral disturbances is common (Biederman, et al., 1991; Barkley, 1998), the presence of more than one diagnosis makes it difficult to draw inferences regarding characteristics specific to one (i.e., ADHD or CAPD). Thus, while

the current participants are likely representative of clinically- referred children in general, firm conclusions regarding typical testing performances of children with ADHD or CAPD cannot be made. The current study does, however, provide further evidence for the incidence of comorbidity of childhood disorders. A final limitation to this study was the lack of information obtained from teachers regarding attention, mood, and behavior. The diagnosis of ADHD requires that a child evidence significant symptoms of inattention, impulsivity and/or hyperactivity across at least two settings (APA, 1994). For a child, these two settings are typically home and school. As such, obtaining information from teachers would help to clarify whether children diagnosed with ADHD differ in the classroom from children diagnosed with CAPD.

Although some of these findings are consistent with other studies, future research is still needed. Research using samples from different geographic regions would enhance the validity and generalizability of the current results. Additionally, comparisons of larger groups of children diagnosed with ADHD and CAPD across multiple self-report, objective, and parent/teacher report measures of attention, mood, and behavior would serve to further clarify the relationship between these two disorders.

This study does have implications for the assessment and treatment of childhood attentional disorders. First, this study provides continued support for the high prevalence of comorbidity of attentional, emotional, and behavioral disturbances in children. Additionally, this study supports previous findings of similar symptom clusters across diagnoses. In particular, many childhood disorders, including ADHD, CAPD, anxiety disorders and depressive disorders have inattention as a core symptom. Clinicians must

continue to complete exhaustive evaluations in order to effectively identify and differentially diagnose disorders of childhood. These evaluations should include objective, self-report, and parent/teacher report measures of visual and auditory attention, mood and anxiety symptoms, and a comprehensive measure of general behavioral concerns.

In summary, results of this investigation provided some support for Central Auditory Processing Disorder as a diagnostic entity separate from Attention Deficit Hyperactivity Disorder. While statistical differences between these two groups across measures of visual attention/concentration, auditory attention/concentration, depression, anxiety, and parental reports of internalizing and externalizing behaviors were not found, clinically distinct profiles did emerge. Future research with larger groups of children and more diverse measures of attention, behavior and mood will serve to further clarify the relationship between ADHD and CAPD.

APPENDIX A

TABLES

Table 1

Means (M), Standard Deviations (SD), and Pearson Product-Moment Correlation Coefficients of Dependent Variables (N = 84)

Dependent Variable	1 CPT	2 TAD-Q	3 TAD-N	4 CDI	5 RCMAS	6 CBCL-I	7 CBCL-E	M	SD
1. CPT	--							8.88	6.90
2. TAD- Q	-.107	--						37.88	28.39
3. TAD- N	-.102	.260*	--					31.51	26.16
4. CDI	.149	.082	.054	--				52.94	10.87
5. RCMAS	.100	-.037	.010	.631**	--			62.01	29.43
6. CBCL-I	-.024	.077	-.071	.214*	.274*	--		59.30	12.49
7. CBCL-E	.100	.025	-.196	.081	-.013	.510**	--	60.30	11.93

(Table Continues)

Table 1 (continued)

* $\underline{p} \leq .05$, ** $\underline{p} \leq .01$

CPT = Conners' Continuous Performance Test- Overall Index (measure of visual attention and concentration: 0-8 [no problems with attention], 8-11[mild attention problems], >11 [significant attention problems]; TAD- Q = Goldman-Fristoe-Woodcock Test of Auditory Discrimination- Quiet Subtest (measure of simple auditory attention/concentration expressed as percentile rank: 0 [significantly impaired auditory attention] to 100 [no impairment in auditory attention]); TAD- N = Goldman-Fristoe-Woodcock Test of Auditory Discrimination- Noisy Subtest (measure of complex auditory attention/auditory processing expressed as percentile rank: 0 [significantly impaired auditory attention/processing] to 100 [no impairment in auditory attention/processing]); CDI = Children's Depression Inventory- Total Score (self-report measure of depressive symptoms expressed as $\underline{T}$ score: 0-59 [within normal limits], 60-64 [mild depressive symptoms], 65 or greater [clinically significant depressive symptoms]); RCMAS = Revised Children's Manifest Anxiety Scale, Total Score (self-report measure of anxious symptoms expressed as percentile rank: 0 [no report of anxious symptoms] to 100 [severe anxious symptoms]); CBCL-I = Achenbach Child Behavior Checklist- Internalizing Scale (parental report of internalizing behaviors expressed as $\underline{T}$ score: 0-59 [within normal limits], 60-64 [borderline], 65 or greater [clinically significant impairment]); CBCL-E = Achenbach Child Behavior Checklist- Externalizing Scale (parental report of externalizing behaviors expressed as $\underline{T}$ score: 0-59 [within normal limits], 60-64 [borderline], 65 or greater [clinically significant impairment]).

Table 2

Means and Standard Deviations for Dependent Variables by Diagnostic Group (N=58)

Dependent Variable	ADHD (N = 20)	CAPD (N = 7)	ADHD/CAPD (N = 6)	Affective Disorders (N = 25)	F-Value
CPT	9.75 (6.15)	5.44 (5.93)	11.76 (7.08)	7.77 (7.58)	1.220
TAD-Q	36.20 (32.37)	42.86 (29.74)	51.83 (28.09)	51.60 (28.23)	1.098
TAD-N	38.50 (28.50)	24.57 (9.09)	7.33 (6.62)	51.40 (22.70)	7.146**
CDI	50.15 (9.21)	57.86 (6.94)	49.33 (8.21)	55.80 (11.93)	1.890
RCMAS	49.00 (29.56)	69.29 (26.88)	75.17 (25.16)	69.96 (23.17)	3.063*
CBCL-I	56.25 (10.32)	62.57 (14.60)	60.00 (19.67)	60.52 (12.93)	0.627
CBCL-E	58.05 (9.61)	62.86 (7.06)	61.67 (18.26)	57.68 (13.33)	0.707

(Table Continues)

Table 2 (continued)

* $\underline{p} \leq .05$, ** $\underline{p} \leq .0001$

CPT = Conners' Continuous Performance Test- Overall Index (measure of visual attention and concentration: 0-8 [no problems with attention], 8-11[mild attention problems], >11 [significant attention problems]; TAD- Q = Goldman-Fristoe-Woodcock Test of Auditory Discrimination- Quiet Subtest (measure of simple auditory attention/concentration expressed as percentile rank: 0 [significantly impaired auditory attention] to 100 [no impairment in auditory attention]); TAD- N = Goldman-Fristoe-Woodcock Test of Auditory Discrimination- Noisy Subtest (measure of complex auditory attention/auditory processing expressed as percentile rank: 0 [significantly impaired auditory attention/processing] to 100 [no impairment in auditory attention/processing]); CDI = Children's Depression Inventory- Total Score (self-report measure of depressive symptoms expressed as $\underline{T}$ score: 0-59 [within normal limits], 60-64 [mild depressive symptoms], 65 or greater [clinically significant depressive symptoms]); RCMAS = Revised Children's Manifest Anxiety Scale, Total Score (self-report measure of anxious symptoms expressed as percentile rank: 0 [no report of anxious symptoms] to 100 [severe anxious symptoms]); CBCL-I = Achenbach Child Behavior Checklist- Internalizing Scale (parental report of internalizing behaviors expressed as $\underline{T}$ score: 0-59 [within normal limits], 60-64 [borderline], 65 or greater [clinically significant impairment]); CBCL-E = Achenbach Child Behavior Checklist- Externalizing Scale (parental report of externalizing behaviors expressed as $\underline{T}$ score: 0-59 [within normal limits], 60-64 [borderline], 65 or greater [clinically significant impairment]).

Table 3

Comparison of Diagnostic Groups Across Possible Predictor Variables as Reported by Parents(N=58)

Variable	ADHD (N = 20)	CAPD (N = 7)	ADHD/CAPD (N = 6)	Affective Disorders (N = 25)	Value	Significance Level
Age	9.64	12.81	10.83	9.92	F = 3.14	p = .032
Gender						
Male	14	5	4	14		
Female	6	2	2	11	X^2 = 1.19	p = .756
Frequent Ear Infections						
yes	11	4	5	12		
no	9	3	1	11	X^2 = 1.95	p = .583
Behavior Problems						
yes	9	4	4	14		
no	11	3	2	9	X^2 = 1.47	p = .689
Adjustment Problems						
yes	5	2	4	8		
no	15	5	2	15	X^2 = 3.68	p = .299

(Table Continues)

Table 3 (continued)

Variable	ADHD (N = 20)	CAPD (N = 7)	ADHD/CAPD (N = 6)	Affective Disorders (N = 25)	Value	Significance Level
Emotional Problems						
yes	6	3	3	9	$\underline{X}^2 = 1.06$	$\underline{p} = .788$
no	14	4	3	13		
				(2 missing values)		
Reading						
failing	2	1	1	1		
below average	10	2	2	7		
average	5	3	3	13		
above average	3	--	--	3	$\underline{X}^2 = 6.82$	$\underline{p} = .656$
		(1 missing value)		(1 missing value)		
Mathematics						
failing	4	1	--	2		
below average	4	1	4	5		
average	11	4	2	13		
above average	1	--	--	4	$\underline{X}^2 = 10.45$	$\underline{p} = .315$
		(1 missing value)		(1 missing value)		

(Table Continues)

Table 3 (continued)

Variable	ADHD (N = 20)	CAPD (N = 7)	ADHD/CAPD (N = 6)	Affective. Disorders (N = 25)	Value	Significance Level
School Attention Problems						
yes	16	5	6	13		
no	2	1	--	4	$\underline{X}^2 = 2.27$	$\underline{p} = .519$
	(2 missing values)	(1 missing value)		(8 missing values)		
School Hyperactivity						
yes	4	--	--	3		
no	7	2	3	8	$\underline{X}^2 = 2.38$	$\underline{p} = .497$
	(9 missing values)	(5 missing values)	(3 missing values)	(14 missing values)		
School Incomplete Assignments						
yes	1	3	--	2		
no	9	1	3	10	$\underline{X}^2 = 8.79$	$\underline{p} = .032$
	(10 missing values)	(3 missing values)	(3 missing values)	(13 missing values)		

Table 4

Agglomeration Coefficients for Cluster Analysis

Number of Clusters	Agglomeration Coefficient	Change in Coefficient to Next Level
10	11.82	----
9	13.19	1.37
8	13.90	0.71
7	15.64	1.74
6	16.78	1.14
5	18.64	1.86
4	21.78	3.14
3	26.27	4.49
2	32.59	6.32
1	41.14	8.55

Table 5

Means and Standard Deviations for Dependent Variables by Cluster (N=84)

Dependent Variable	Cluster 1 (N = 32)	Cluster 2 (N = 14)	Cluster 3 (N = 23)	Cluster 4 (N = 15)
CPT	2.39 (3.17)	10.90 (5.76)	14.03 (4.57)	12.96 (5.84)
TAD-Q	39.34 (23.36)	21.14 (13.50)	22.13 (14.41)	74.53 (30.72)
TAD-N	32.66 (24.53)	11.93 (7.43)	30.48 (28.72)	48.93 (25.80)
CDI	49.63 (7.69)	45.86 (6.49)	61.47 (12.01)	53.13 (10.08)
RCMAS	58.75 (25.34)	26.79 (15.35)	89.30 (11.88)	60.00 (27.91)
CBCL-I	58.63 (13.06)	56.86 (8.31)	59.61 (12.77)	62.53 (14.42)
CBCL-E	56.25 (9.97)	70.07 (8.68)	59.04 (13.24)	61.73 (11.87)

(Table Continues)

Table 5 (continued)

CPT = Conners' Continuous Performance Test- Overall Index (measure of visual attention and concentration: 0-8 [no problems with attention], 8-11[mild attention problems], >11 [significant attention problems]; TAD- Q = Goldman-Fristoe-Woodcock Test of Auditory Discrimination- Quiet Subtest (measure of simple auditory attention/concentration expressed as percentile rank: 0 [significantly impaired auditory attention] to 100 [no impairment in auditory attention]); TAD- N = Goldman-Fristoe-Woodcock Test of Auditory Discrimination- Noisy Subtest (measure of complex auditory attention/auditory processing expressed as percentile rank: 0 [significantly impaired auditory attention/processing] to 100 [no impairment in auditory attention/processing]); CDI = Children's Depression Inventory- Total Score (self-report measure of depressive symptoms expressed as T score: 0-59 [within normal limits], 60-64 [mild depressive symptoms], 65 or greater [clinically significant depressive symptoms]); RCMAS = Revised Children's Manifest Anxiety Scale, Total Score (self-report measure of anxious symptoms expressed as percentile rank: 0 [no report of anxious symptoms] to 100 [severe anxious symptoms]); CBCL-I = Achenbach Child Behavior Checklist- Internalizing Scale (parental report of internalizing behaviors expressed as T score: 0-59 [within normal limits], 60-64 [borderline], 65 or greater [clinically significant impairment]); CBCL-E = Achenbach Child Behavior Checklist- Externalizing Scale (parental report of externalizing behaviors expressed as T score: 0-59 [within normal limits], 60-64 [borderline], 65 or greater [clinically significant impairment]).

Table 6

Comparison of Cluster Subgroups Across Possible Predictor Variables (N=84)

Variable	Cluster 1 (N = 32)	Cluster 2 (N = 14)	Cluster 3 (N = 23)	Cluster 4 (N = 15)	Value	Significance Level
Age	9.64	11.18	10.23	10.57	F = 1.784	p = .150
Gender						
Male	23	10	11	10		
Female	9	4	12	5	X^2 = 3.87	p = .276
Diagnostic Category (26 missing values)						
ADHD	7	4	4	5		
CAPD	3	1	2	1		
ADHD/CAPD	1	1	2	2		
no ADHD/no CAPD	13	---	6	6	X^2 = 7.40	p = .596

APPENDIX B

DEVELOPMENTAL HISTORY

COOK CHILDREN'S BEHAVIORAL HEALTH SERVICES

DEVELOPMENTAL HISTORY

Patient's Name: _____Sex: M _____ F _____

Patient's Address:_____
Phone: _____

Date of Birth: _____Age: _____
Birthplace: _____

Other Names Used or Nickname: _____
School: _____

Phone: Mother (work) _____
Father (work): _____ Home: _____

FAMILY COMPOSITION

LIST BY NAME MEMBERS OF CHILD'S FAMILY in order of age, beginning with older parent first, including mother, father, brothers and sisters of child. Please include half-sisters and half-brothers, step-parents and step-brother and step-sisters.

Member	Age	Date of Birth	Relationship	Lives In the Home	Occupation and level of education
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Parents' Marital Status _____

PRESENTING PROBLEMS

What are the problems that caused you to seek help here for your child?

_____

Please list specific problems:

_____

Did anything happen at the same time these problems began
that may have caused these problems? _____

If yes, please explain

_____

Was there ever a time when these problems were better? _____If so, when and what washappening at that time

_____

_____

How long have you had these problems with your child? _____

MEDICAL AND DEVELOPMENTAL HISTORY

This is a very important section of our study of your child. The information you furnish, is held in confidence. Please answer in the blanks provided.

Was child adopted? _____ If so, at what age? _____

Current Medical Problems? _____

Primary Care Physician, Pediatrician or Family Physician_____

Date last seen (Must have been seen within 12 months) _____

MEDICAL HISTORY

	Yes	No
Meningitis or encephalitis?	____	____
Several High Fevers?	____	____
Head injury?	____	____
Weakness?	____	____
Frequent ear infections?	____	____
Vision problems?	____	____
Hearing difficulties?	____	____
Episodes of unnsciousness?	____	____
Speech difficulties?	____	____
Emotional problems?	____	____
Allergies?	____	____
Adjustment problems?	____	____
Seizures?	____	____
Behavioral problems?	____	____
Blank spells?	____	____
Headaches?	____	____
Dizziness?	____	____
Stomach ache?	____	____
Nausea?	____	____

Please explain any yes answers:

_____

Present Medications (Names and Dosage):
_____
_____

BEFORE BIRTH

Were any of these conditions present during the mother's pregnancy?
Rh or other blood incompatibility _____

Falls _____	Thyroid _____	Toxemia _____
German Measles _____	High/Low Blood Pressure _____	Use of Nonprescribed Drugs _____
DrinkingAlcohol _____	Bleeding _____	Depression _____
Smoking Cigarettes _____	Nausea _____	Headaches _____
Accidents _____	Swelling _____	Vomiting _____
Infections _____	Convulsions _____	Diabetes _____
Anemia _____	Heart Disease _____	Kidney Disease _____

Any hospitalization during pregnancy: Yes _____ No _____

If yes, explain:
_____

Other complications:
_____

What were the stressors during the pregnancy?_____

Total weight gain _____ Length of pregnancy _____

Please list all medications taken during pregnancy
_____

Was the pregnancy planned? _____ Was the pregnancy desired? _____

AT THE TIME OF BIRTH

Type of anesthesia _____
Type of delivery:
Natural _____ Forceps_____ Cesarean _____ Breech _____

Length of labor _____

Labor Induced _____

Did baby have problems with:

Resuscitation required _____	Born at home _____	Incubation _____
Breathing _____	Cord Around Neck _____	Jaundice _____
Bleeding _____	Infection _____	Colic _____

Placed on Respirator _____

Birth Weight _____	Length _____	Normal Color _____

Premature _____ How Early _____

Other problems at birth

_____

Hospital _____
Location _____

INFANCY AND EARLY CHILDHOOD

1) From birth to age three who was the child's primary caretaker?

_____

2) Were there periods caretaker was away from the child? _____

If so, for how long? _____

Who cared for child during those times?

_____

3) Did the primary caretaker experience any significant difficulties during this period?

Extended Illness _____	Loss of Own Parent _____	Chemical Dependency _____
Hospitalization _____	"Baby Blues" _____	Depression _____
Divorce / Separation _____	Financial Stresses _____	Frequent Moves _____

Spouse Abuse _____

4) If the caretaker worked outside the home, who provided child care during this period?

_____

How many different child care settings was the child in? _____

Was your child a cuddly baby? _____ Irritable baby? _____

At what age did your child?

Sit Alone _____	Stay dry during day _____	Sleep through the night _____
Walk _____	Stay dry during night _____	Not soil underwear _____
Crawl _____	Speak several words together _____	Speak in sentences _____

CHILDHOOD

Please describe your child's temperament or disposition:

_____

Please describe temperament of mother:

_____

Of father:

_____

Which best describes your child's development? _____ Slow _____ Fast _____ Normal

What is your opinion of your child's intelligence? _____ Average _____ Below Average

_____ Above Average

Additional

Comments:_____

_____

_____

At what age did your child ride a standard tricycle? _____

A bicycle without training wheels? _____

Does your child wet the bed or pants? _____ How often? _____

Does your child soil his/her pants? _____ How often? _____

Does the Child Know How To?

Brush teeth _____

Dress self _____

Use toilet without help _____

Make bed _____

Comb hair _____

Tie Shoes _____

Tell time by a nondigital clock _____

SEXUAL DEVELOPMENT

Age at onset of menstruation (if applicable) _____

Has child had sex education? _____ By whom? _____

Have menses been regular? _____

Have there been problems in the sexual adjustment of the child? _____ Please explain?
_____
_____
__

Has child been sexually abused? _____ When and by whom?
_____
_____
__

DISCIPLINE
Child is most often disciplined by: _____

Discipline **most** effective with the child
_____

Discipline **least** effective with the child
_____

Explain briefly the child's most common reactions to discipline
_____
_____

Has child ever been physically abused? _____
By whom? _____

SOCIAL DEVELOPMENT

Does the child have problems relating with?

Children of own age?_____ Teachers? _____

Brothers/Sisters? _____ Other adults? _____

Parents? _____

Does child have problems separating from mother? _____ or from father? _____

Does the child like to play with children:
Own age? _____ Younger? _____ Older? _____

Does child have:
Many friends? _____ Few friends? _____ No friends? _____

Is the child a:
Leader? _____ Follower? _____ Loner? _____

SCHOOL HISTORY

Did the child attend preschool? _____ Age? _____
Child entered first grade at what age? _____
Is the child in Special Education? _____ Since what grade? _____
Has the child ever repeated a grade? _____
How many schools has your child attended? _____
Is your child currently experiencing difficulty in school?_____

Problems With:

Reading _____ Math _____ Writing _____ Attention _____

Memory _____ Social _____

Please explain any yes answers:
_____

JUVENILE HISTORY

Does the child care about the rights of others? _____
Does the child like making others angry? _____
Does the child break rules on purpose? _____
Does the child like to do the opposite of what is asked by people in charge? _____
Is the child disobedient? _____
Has the child ever had problems involving the police or juvenile authorities? _____

If yes, when and why
_____

Is the child on probation? _____

Where: _____

Child's Probation Officer: _____

FAMILY HISTORY:

Please check if anyone in your family (parents, grandparents, siblings, aunts, uncles) has ever had any of the following problems

	Mother's Side	Father's Side
ADHD (attention problems/hyperactivity)	_____	_____
Learning Disorder	_____	_____
Depression/Suicide	_____	_____
Anxiety/Excessive Worry	_____	_____
Obsessive Compulsive symptoms (e.g. excessive handwashing, checking, performing rituals)	_____	_____
Panic Attacks	_____	_____
Alcohol/Drug Use	_____	_____
Schizophrenia	_____	_____
Bipolar Disorder (Manic Depression)	_____	_____
Problems with the Law	_____	_____
History of Seizures	_____	_____

RELIGIOUS HISTORY

Child's Religion: _____

Child attends church: ___Regularly ____Occasionally _____Seldom _____Never

Has there been a recent change in religious beliefs? _____

If yes, please explain
_____

How important is religion to your child? _____
How important is religion to your family? _____

PREVIOUS TESTING OR THERAPY:

Previous Psychological Testing: Yes_____ No_____

If yes, where and when was testing accomplished:_____
_____

What were the results?_____
_____

Previous Therapy: Yes _____ No _____

If yes, please provide dates and duration of therapy:_____
_____

Did treatment include medication: _____ Yes _____ No

If yes, what medications and duration of medication:_____

Effectiveness of therapy treatment: Positive _____ Negative _____
No Change _____

_____ _____ _____

SIGNATURE RELATIONSHIP TO CHILD DATE

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